

## TWO NEW SPECIES OF *CTENOTUS* (REPTILIA, SCINCIDAE) FROM THE NORTHERN TERRITORY.

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### ABSTRACT

Two new species of *Ctenotus* Storr (Reptilia, Scincidae), *C. astictus* sp. nov. and *C. stuarti* sp. nov. are described and their habitat preferences and distribution in the Northern Territory are discussed. Both species are closely allied to *C. arnhemensis* Storr and are distinguished from that species by a combination of body pattern, and morphological and meristic characteristics. *Ctenotus arnhemensis* is redescribed.

KEYWORDS: Reptilia, Scincidae, *Ctenotus*, new species, Northern Territory.

### INTRODUCTION

The genus *Ctenotus* Storr, 1964, is the most speciose taxon of scincid lizards found in Australia. It includes 82 species (Cogger 1992) which are distributed throughout the continent and only one of these extends to southern New Guinea.

*Ctenotus* species are found through a diverse array of habitats, ranging from arid deserts to tropical savanna woodland, with many being sympatrically distributed. Syntopy is common with 12 species sharing the same habitat in Uluru National Park, Northern Territory (Reid *et al.* 1993) and seven species in one region of arid south west Australia (Pianka 1969). *Ctenotus* is most diverse in the arid regions of Australia. However, of the 40 species known to occur in the Northern Territory, 22 are found in the arid centre and 15 in the tropical north (Horner 1992). Many of the northern species are specialised tropical forms and it is now becoming apparent that these may have very restricted distributions, exhibiting a high degree of habitat specificity.

The 'Top End' of the Northern Territory presents a paradox in the knowledge of its fauna. Access to many extensive tracts of land is very poor and these have been sparsely surveyed biologically, if at all. In contrast, the 19,757 square kilometre expanse of centrally located Kakadu National Park boasts one of the best

known faunas in Australia. Field work by the author in certain accessible areas of the Top End has shown that specimens putatively identified as *C. arnhemensis* exhibited two forms of non-random colour variation. Following the availability of sufficient specimens these forms were considered to represent new species and are here described and compared to *C. arnhemensis*, whose original description is herein expanded. The two new species and *C. arnhemensis* form a closely allied species group which is termed the *C. arnhemensis* species-complex.

### MATERIALS AND METHODS

A detailed morphometric and meristic analysis was made on a series of 25 specimens of two previously undescribed species of *Ctenotus* and on nine specimens of *C. arnhemensis*. Fourteen scale counts and eleven measurements were made on each specimen. Measurements were made with micrometer adjusted callipers and/or a steel rule. Counts of supraocular, supraciliary, ciliary, supralabial and infralabial scales, subdigital lamellae and ear lobules were made on both sides of the body.

Of the measurements and counts taken, the following require individual definition:

1. Ear-snout (head) length: measured from the anterior margin of the ear orifice to the tip of the rostral scale;



2. Eye-snout (snout) length: measured from the anterior margin of the orbit to the tip of the rostral scale;

3. Limb length: measured along the posterior edge, from the body wall to the tip of the longest toe (claw excluded);

4. Fourth toe length: measured from the angle between the third and fourth toes to the tip of the fourth toe (claw excluded);

5. Forelimb to snout length: measured from the anterior margin of the forelimb, at the body wall, to the tip of the rostral scale;

6. Paravertebral scales: counted from first scale behind parietals to a point midway between the hindlimbs.

Scalation and body pattern nomenclature follows that of Horner (1992).

The following abbreviations are used in the text: AM, Australian Museum; NTM, Museum and Art Gallery of the Northern Territory.

## SYSTEMATICS

Members of the *C. arnhemensis* species-complex have the following character states in common with most other *Ctenotus*. Body elongate, slender, as wide as deep. Tail slender, round in section and tapers to point. Well-developed pentadactyl limbs with long, pointed digits. Dorsal scales smooth with four parallel rows of larger paravertebral scales extending from nuchals to tail. Lateral scales small and smooth. Scales on abdomen twice as large as lateral scales. Subcaudal scales single and very large. Head wider than deep. Snout pointed. Lower eyelid moveable, opaque. Nasal scales separated by rostral and frontonasal scales. Frontoparietal scales paired. Interparietal scale distinct. Parietal scales large and in contact behind interparietal scale. Two loreal scales. Upper and lower preocular scales present, lower much the larger. Presubocular scale present. Single primary temporal scale and two secondary temporals. Auricular opening large, ovoid with obtusely pointed lobules on anterior margin.

The following five character states in combination place them in the *C. lesueurii* species-group of Storr (Storr 1981; Storr *et al.* 1981). Digits slightly compressed with moderately broad, dark calli on the subdigital lamellae. Four supraocular scales, first three contacting frontal, second larger than first, third and fourth. Supraciliary scales very disparate in size (fourth to eighth much smaller than others). Ear lobules

large and graded in size. Colour pattern includes a wide, dark, white-edged vertebral stripe.

Members of the complex are distinguished from other members of the *C. lesueurii* species-group by the following six character states in combination. Body dorsal surface with three dark longitudinal stripes. Prefrontal scales not in contact. Maximum snout-vent length less than 60 mm. Midbody scale rows 26 or less. Usually seven supralabials. Subdigital lamellae under the fourth toe, 21-26.

The three members of the *C. arnhemensis* species-complex are distinguished from each other by a combination of morphological, meristic and colour pattern characteristics.

### *Ctenotus astictus* sp. nov.

(Figs 1-2)

**Type material.** HOLOTYPE - NTMR.11252, 14 kilometres west of Numbulwar on Ngukurr road, 14°14'S 135°36'E, Northern Territory, coll. I. Archibald, 07 June 1983. PARATYPES - NORTHERN TERRITORY: NTM R.11250-51, same data as holotype; NTM R.14183, Lake Eames, Vanderlin Island, Sir Edward Pellew Group, 15°41'S 137°02'E; NTM R.16113, R.16134-35, R.16140-44, Cadell River crossing, 12°15'S 134°26'E; NTM R.16177, Liverpool River crossing, 12°22'S 134°07'E; NTM R.19151, R.19153, Red Point, Marchinbar Island, Wessel Islands, 11°16'S 136°35'E; NTM R.20252, Bumaga Island, Wessel Islands, 11°46'S 136°05'E.

**Additional material.** Northern Territory: juveniles, NTMR.11248-49, same data as holotype.

**Diagnosis.** *Ctenotus astictus* sp. nov. is distinguished from *C. arnhemensis* and *C. stuarti* sp. nov. by having a reduced, simple lateral pattern which lacks any form of pale spots or blotches and by having generally fewer ear lobules (mean of 2.9 vs means of 4.8 and 4.1 respectively). Additionally, the relative lengths of the limbs and tail are generally greater in *C. astictus* sp. nov. than in *C. arnhemensis* and *C. stuarti* sp. nov.

*Ctenotus astictus* sp. nov. is superficially similar to well patterned specimens of *C. vertebralis*, but may be distinguished by possessing a grey-brown rather than black upper lateral zone, wider second supraocular scale and fewer ear lobules and supralabial scales.

**Description.** Head. Snout length 39-49% (mean = 42.4%) of head length. Prefrontal scales usually separated by frontal scale (87%), occa-





Fig. 1. Paratype of *Ctenotus astictus* sp. nov. (NTMR. 16143) from Cadell River crossing, Arnhem Land, Northern Territory, photographed in life.

sionally in narrow contact. Nuchal scale pairs usually four (69%), occasionally five (25%) or three (6%). Supraciliary scales usually ten (81%), occasionally nine or eleven, fourth to eighth markedly smaller than others. Ciliary scales usually ten (44%) or eleven (44%), occasionally nine or twelve. Supralabial scales usually seven (94%) occasionally eight, fifth under orbit. Infralabial scales usually seven (93%) occasionally eight, two contacting postmental. Ear lobules usually three (69%) or four (25%), rarely two (6%).

**Body.** Snout-vent length to 51.9 mm (mean = 47.1 mm). Axilla to groin length 49-58% (mean = 52.3%) of snout-vent length. Tail length 211-239% (mean = 228.3%) of snout-vent length. Paravertebral scales 48-56 (mean = 52.7). Midbody scale rows usually 24 (87%), occasionally 26 (12%).

**Limbs.** Forelimb length 25-32% (mean = 28.4%) of snout-vent length. Hindlimb length 42-52% (mean = 48.2%) of snout-vent length. Fourth toe length 15-19% (mean = 17.3%) of snout-vent length. Subdigital lamellae under fourth toe 21-25 (mean = 22.4) excluding claw.

**Colour and pattern (in spirit).** The basic body pattern is of a reduced form, consisting of a simple arrangement of smooth-edged, longitudinal stripes and zones of ground colour. Pale spotting is virtually absent.

**Body.** Dorsal surface of body mid-brown with simple pattern of smooth edged stripes. Dark blackish-brown vertebral stripe, half as wide as paravertebral scales, extends from anterior nuchal scales to base of tail. Vertebral stripe margined by white paravertebral stripes which are about one third as wide as vertebral stripe. Paravertebral stripes bordered by zone of mid-brown background colour, about as wide as paravertebral scales, which extends from parietal scales onto tail. Outer margins of background colour zones bordered by prominent blackish-brown laterodorsal stripes, about three quarters as wide as vertebral stripe, which extend from outer edge of parietal scales onto tail. Outer margins of laterodorsal stripes bordered by distinct white dorsolateral stripes, about half as wide as vertebral stripe, which extend from outer edge of the fourth supraciliary scales onto tail.

Lateral surface of body grey-brown patterned with two pale, smooth edged stripes. Broad grey-



brown upper lateral zone extends from above auricular opening onto tail. This is separated from mid-lateral zone by prominent white upper lateral stripe, about one third as wide as upper lateral zone, which extends from upper posterior margin of auricular opening, above the limbs, onto tail. Grey-brown mid-lateral zone, about three quarters as wide as upper lateral zone, extends from posterior margin of auricular opening to base of tail. This is separated from lower lateral zone by an obscure, pale lower lateral stripe, about as wide as upper lateral stripe, which extends from lower posterior margin of auricular opening to forelimb, behind which it continues to hindlimb. Obscure, grey-brown lower lateral zone, about half as wide as upper lateral zone, extends from below auricular opening to hindlimb, and coalesces into immaculate whitish ventral surface.

**Head.** Snout light brown. Dark mottling on frontal, frontoparietal, interparietal and parietal scales. Temporal region mid-brown, patterned with broken pale stripe, (or series of pale blotches), which extends from anterior temporal scales to above auricular opening. White subocular stripe extends from lower preocular scale to upper margin of auricular opening. Supralabials light brown with pale margins between scales. Infralabials mottled brown and off-white. White ventral surface changing to cream on chin.

**Limbs.** Mid-brown background colouration on dorsal surface of forelimbs separating three black stripes. Cream on ventral surface. Hindlimbs similar but with four black stripes.

**Tail.** Light brown on dorsal surface. Basal portion has remnants of dark vertebral stripe. Continuations of dark laterodorsal stripes, pale dorsolateral stripes, upper lateral zone and pale upper lateral stripe extend along length of tail. Cream on ventral surface.

**Details of holotype.** (NTM R.11252). Snout-vent length 50.3 mm; tail length 106.0 mm; axilla to groin length 29.3 mm; forelimb length 13.7 mm; hindlimb length 21.4 mm; fourth toe length 7.8 mm; head width 5.4 mm; head depth 4.9 mm; eye to snout length 4.2 mm; ear to snout length 9.9 mm; forelimb to snout length 16.9 mm; nasals separated; prefrontals separated; supraciliaries ten on both sides; ciliaries ten on both sides; supralabials seven on both sides; infralabials seven on both sides; nuchals four pairs; ear lobules two on left side, three on right side, uppermost largest; subdigital lamellae of fourth toe 22 on both sides; midbody scale rows 24; paravertebral scales 54.

**Variation.** The 16 specimens analysed are generally uniform in most characteristics of scalation, morphology, colouration and pattern. Any variation in morphology and meristics is summarised in Table 1.

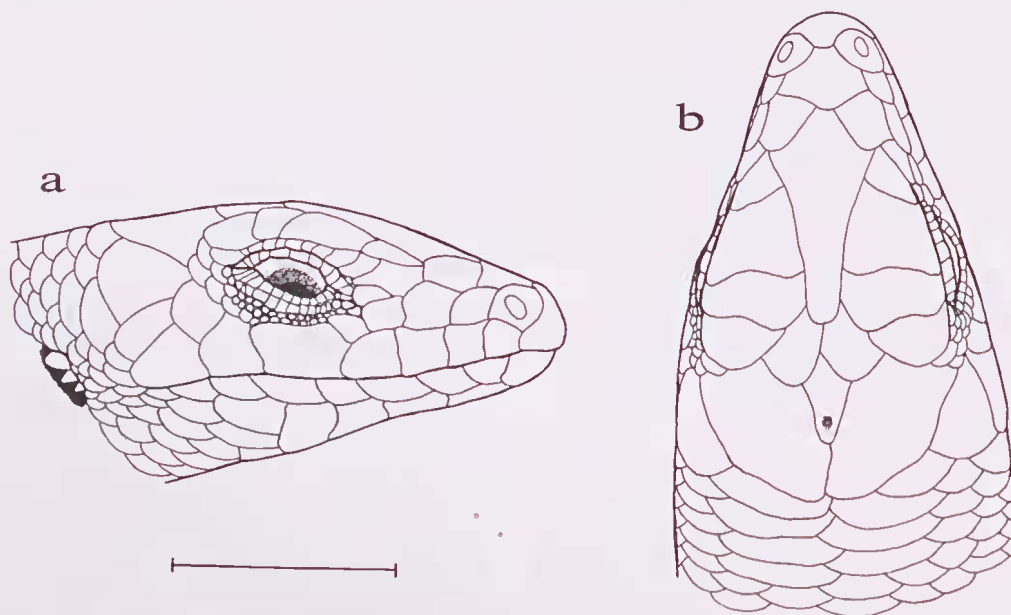


Fig. 2. Holotype of *Crenotus astictus* sp. nov. (NTM R.11252). Head scalation in a) right lateral and b) dorsal view. Scale bar = 5 mm.



**Distribution.** The known distribution of *C. astictus* sp. nov. is north-eastern Northern Territory. It has been collected near Numbulwar and at the Cadell and Liverpool river crossings in Arnhem Land, and on Marchinbar and Bumaga Islands in the Wessel Islands group and Vanderlin Island in the Sir Edward Pellew Group.

**Habitat.** Mainland specimens were found in low-lying, white sandy flats vegetated by open *Eucalyptus* woodlands or tall, open *Acacia* shrubland. All were collected from sites with a ground storey of perennial grass tussocks on a pale sandy substrate, adjacent to watercourses. The Vanderlin Island site supported *Eucalyptus*-dominated low, open woodland with a open, hummock-grassland understorey of *Plectrachne pungens*. Specimens from the Wessel Islands were collected at three sites, descriptions of which are: 1, flat bordering rocky coastline with a mixed strand community of scattered tall *Casuarina equisetifolia*, small dense patches of strandline, coastal monsoon vine forest and mixed low tussock grasses and forbs, on loamy humic sand substrate; 2, gently undulating, extensive sand flat behind beach with a low woodland of *Acacia plectocarpa* and *Melaleuca nervosa*, and a sparse understorey of small shrubs and *Triodia microstachya*; 3, sandy crest and upper slopes of low hind-dune with a mosaic of small, dense thickets of coastal monsoon vine forest, and a low, mid-dense understorey of herbs and tussock grasses plus scattered *Triodia microstachya* hummocks.

*Ctenotus astictus* sp. nov. specimens have been recorded using shallow ground burrows for shelter and small juveniles (26–29 mm in snout-vent length) were collected near Numbulwar in June.

Specimens of *C. essingtonii* were also collected at the Cadell and Liverpool river sites.

**Etymology.** The species name *astictus* is derived from the Greek term *stiktos* which means 'spotted'. It refers to the unspotted nature of the body pattern in comparison to *C. arnhemensis* and *C. stuarti* sp. nov.

*Ctenotus stuarti* sp. nov.  
(Figs 3–4)

**Type material.** HOLOTYPE - NTMR.13723, Swim Creek, Opium Creek Station, 12°34'30"S 131°49'30"E, Northern Territory, coll. P. Horner, 24 April 1988. PARATYPES - NORTHERN TERRITORY: NTM R.13086–87, same data as holotype except 24 April 1985; NTM R.13722,

R.13724–27, same data as holotype; NTM R.17453, Kapalga, 12° 40'S 132° 22'E.

**Diagnosis.** *Ctenotus stuarti* sp. nov. is distinguished from *C. astictus* sp. nov. by having a complex lateral pattern of stripes, pale spots and blotches, and by having generally more ear lobules (mean of 4.1 vs mean of 2.9). Additionally, the relative lengths of the limbs are generally less in *C. stuarti* sp. nov. than in *C. astictus* sp. nov.. *Ctenotus stuarti* sp. nov. is distinguished from *C. arnhemensis* by having a generally lower number of subdigital lamellae under the fourth toe (mean of 20.9 vs mean of 22.9) and by having generally more nuchal scale pairs (mean of 4.7 vs mean of 3.8). Also, the head of *C. stuarti* sp. nov. is usually deeper than that of *C. arnhemensis* (head depth as percentage of head width, mean of 88.6% vs mean of 85.7%). In addition, the continuous, smooth-edged, white dorsolateral stripes and dark laterodorsal stripes found in *C. arnhemensis* and other members of the *C. lesueurii* species-group are broken into ragged-edged, semi-continuous series of flecks and streaks in *C. stuarti* sp. nov.

**Description.** *Head.* Snout length 38.6–54.2% of head length. Prefrontal scales usually separated by frontal scale (89%), occasionally in narrow contact. Nuchal scale pairs usually five (89%), occasionally four. Supraciliary scales usually nine (63%), occasionally ten, fourth to eighth markedly smaller than others. Ciliary scales usually eleven (50%) or ten (38%), occasionally twelve. Usually seven supralabial scales (88%), occasionally eight, fifth under orbit. Infralabial scales seven, two contacting postmental. Ear lobules usually four (78%), occasionally with five or six.

*Body.* Snout-vent length to 52.0 mm (mean = 48.8 mm). Axilla to groin length 49–54% (mean = 51.6%) of snout-vent length. Tail length 204–226% (mean = 215%) of snout-vent length. Paravertebral scales 50–58 (mean = 54.3). Midbody scale rows usually 24 (44%) or 26 (33%), occasionally 25.

*Limbs.* Forelimb length 24–28% (mean = 26%) of snout-vent length. Hindlimb length 41–45% (mean = 43.5%) of snout-vent length. Fourth toe length 13–16% (mean = 14.4%) of snout-vent length. Subdigital lamellae under fourth toe 18–23 (mean = 20.9) excluding claw.

**Colour and pattern (in spirit).** The basic body pattern consists of a complex arrangement of longitudinal stripes, zones of ground colour, pale spots and blotches.



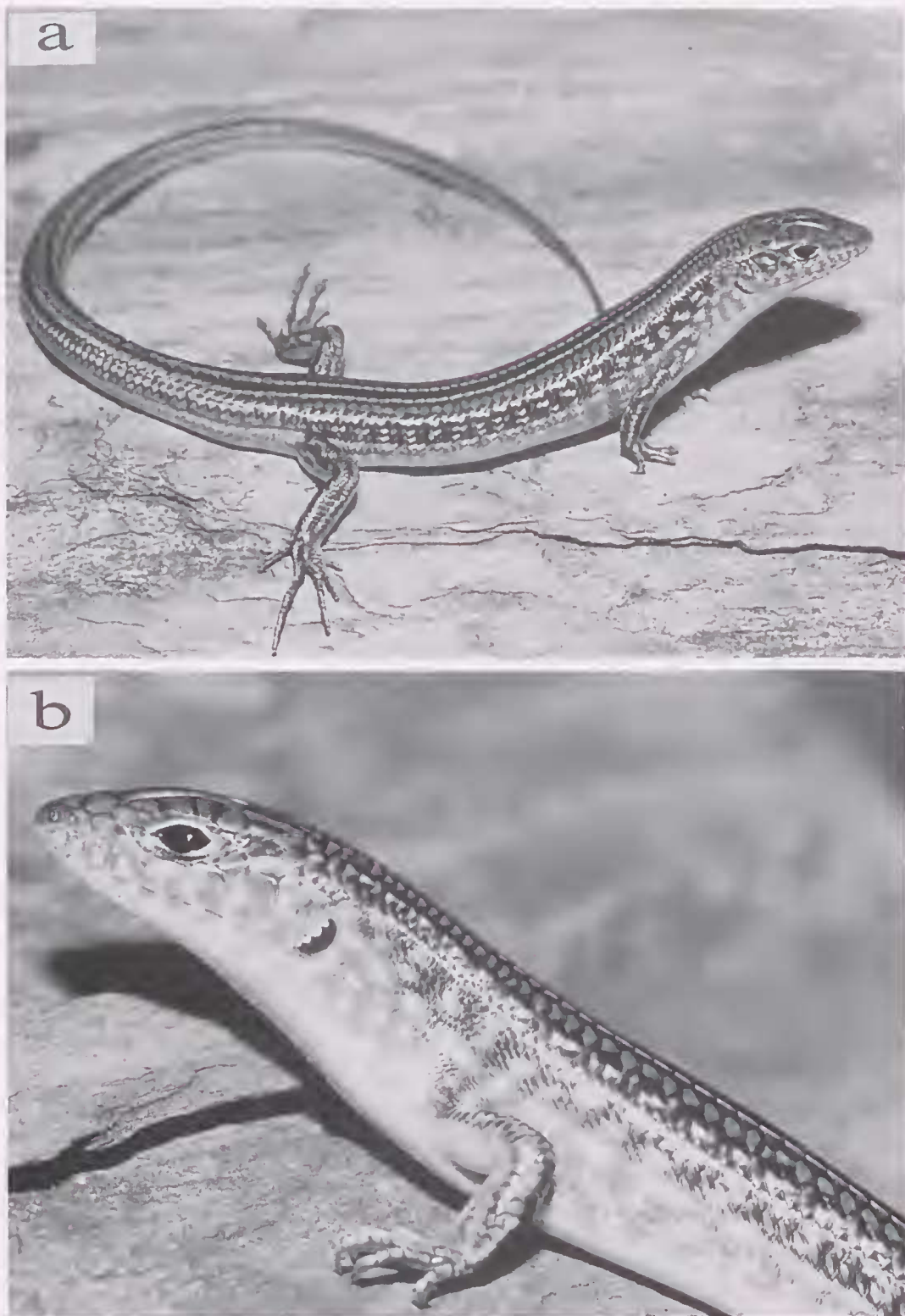


Fig. 3. a) Holotype of *Ctenotus stuarti* sp. nov. (NTM R.13723) from Swim Creek, Opium Creek Station, Northern Territory photographed in life. b) Detail of forebody. Note discontinuous series of streaks representing dark laterodorsal and pale dorsolateral lines.



**Body.** Dorsal surface olive-brown with complex pattern of smooth and ragged edged stripes. Dark, smooth-edged, blackish-brown vertebral stripe, half as wide as paravertebral scales, extends from posterior edge of parietal scales to base of tail. Vertebral stripe margined by smooth-edged, white paravertebral stripes about one third as wide as vertebral stripe. Paravertebral stripes bordered by zone of olive-brown background colour, about as wide as paravertebral scales, which extends from parietal scales onto tail. Outer margins of background colour zones bordered by obscure, narrow, laterodorsal series of irregular blackish-brown flecks and streaks, which extend, as an irregular, discontinuous stripe, from upper edge of primary temporal scales onto tail. This dark laterodorsal series merges with distinct discontinuous, white, dorsolateral stripe. Formed by ragged-edged, series of flecks and streaks, this continuously broken stripe, about half as wide as vertebral stripe, extends from outer edge of fourth supraciliary scales onto tail. Interspaces in the series often as wide as white streaks, coloured with mingling of blackish-brown laterodorsal series and brown upper lateral zone.

Lateral surface of body brown, patterned with pale spots and blotches and, at least posteriorly, a pale mid-lateral stripe. Broad brown upper lateral zone extends from above auricular open-

ing onto tail, patterned with one or two irregular series of 18-22 small pale blotches; zone separated from lower lateral zone by white mid-lateral stripe, about one third as wide as upper lateral zone, which extends from above forelimb to hindlimb, behind which it continues onto tail. This stripe is often indistinct and may be broken on anterior half of body, as series of elongated blotches. Between forelimb and auricular opening, mid-lateral stripe represented by two or three pale blotches. Mottled grey-white lower lateral zone, about half as wide as upper lateral zone, extends from below auricular opening to hindlimb, patterned anteriorly by numerous, obscure, pale spots and blotches; and coalesces into immaculate whitish ventral surface.

**Head.** Snout light brown. Dark mottling on supraoculars, frontal, frontoparietal, interparietal, parietal and nuchal scales. Temporal region patterned with three or four irregular pale blotches. Ragged white subocular stripe extends from second loreal scale to mid-upper margin of subocular scale (fifth supralabial), then extends along upper margin of posterior supralabial scales as irregular series of three or four pale blotches. Supralabials mottled grey-white with pale margins between scales giving barred appearance. Infralabials mottled white-grey. White ventral surface changing to cream on chin.

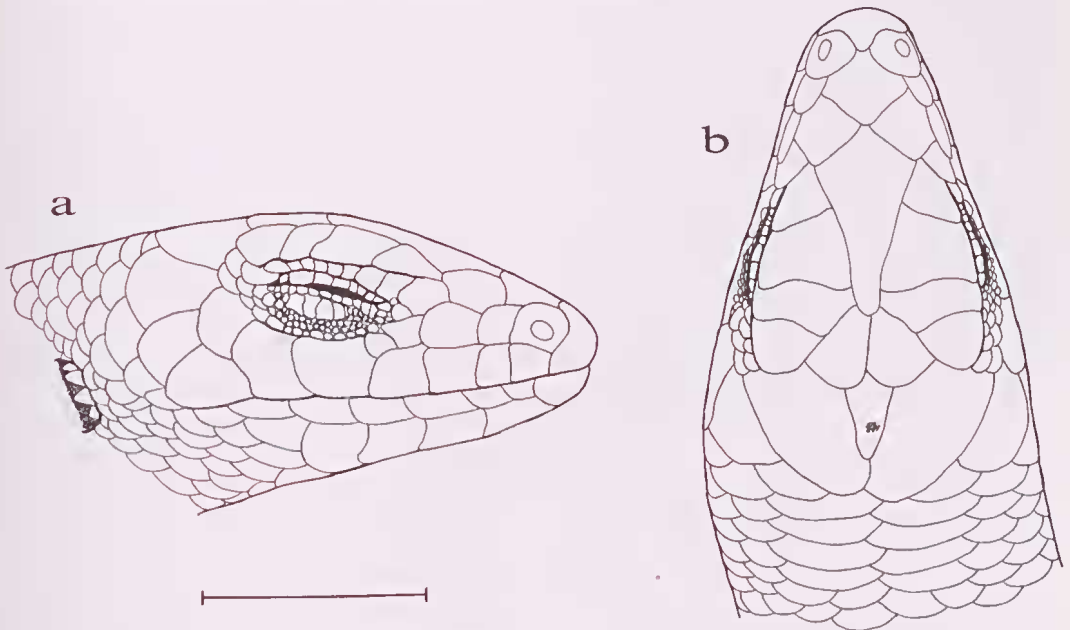


Fig. 4. Holotype of *Ctenotus stuarti* sp. nov. (NTM R.13723). Head scalation in a) right lateral and b) dorsal view. Scale bar = 5 mm.



**Limbs.** Mid-brown background colouration on dorsal surface of forelimbs separating three black stripes. Cream on ventral surface. Hindlimbs similar but with four black stripes.

**Tail.** Light brown on dorsal surface. Basal portion with remnants of dark vertebral stripe. Continuations of dark laterodorsal stripes, pale dorsolateral stripes and pale mid-lateral stripes extend along length of tail. Cream on ventral surface.

**Details of holotype.** (NTM R.13723). Snout-vent length 52.0 mm; tail length 106.0 mm; axilla to groin length 26.1 mm; forelimb length 13.3 mm; hindlimb length 21.3 mm; fourth toe length 7.4 mm; head width 6.5 mm; head depth 5.8 mm; eye to snout length 4.3 mm; ear to snout length 10.5 mm; forelimb to snout length 18.0 mm; nasals separated; prefrontals separated; supraciliaries ten on both sides; ciliaries eleven on both sides; supralabials seven on both sides; infralabials seven on both sides; nuchals five pairs; ear lobules four on both sides, second from top largest; subdigital lamellae of fourth toe 20 on both sides; midbody scale rows 26; paravertebral scales 53.

Heart and liver tissue samples were taken from the holotype at death. These are lodged in the South Australian Museum's tissue bank under the number SAM-EBU H73.

**Variation.** The nine specimens analysed are generally uniform in most characteristics of scalation, morphology, colouration and pattern. Any variation in morphology and meristics is summarised in Table 1. One individual from Kapalga differs slightly by possessing more continuous laterodorsal and dorsolateral stripes. In this specimen they are only occasionally interrupted by an intrusion of background colour.

**Distribution.** The known distribution of *C. stuarti* sp. nov. is restricted to two localities. Opium Creek Station, 100 kilometres east of Darwin, where it was collected adjacent to Swim Creek (this property is a recent subdivision of Point Stuart Station), and CSIRO Research Station, Kapalga, approximately 65 kilometres further east.

**Habitat.** Specimens from Swim Creek were collected on a gently sloping, white sandy flat supporting a low open woodland. The site is low lying, adjoining a shallow, seasonal drainage channel, extending about 100 metres, which empties into perennial Swim Creek. The site's dominant vegetation types are low, scattered tree and shrub species and a moderately thick to

sparse groundstorey of perennial grass and sedge tussocks. Surrounded by open *Eucalyptus* forest on other soil types. Prominent shrub/tree species are *Jacksonia dilatata*, *Melaleuca cajuputi*, *Verticordia cunninghamii*, *Calytrix extipulata* and *Grevillea pteridifolia*. Numerous *C. stuarti* sp. nov. specimens were seen in the immediate area and observations on their activity indicate that the species retreats to shallow ground burrows for protection, occasionally climbs into low vegetation whilst foraging and (during the monsoonal wet season) remains in areas where the substrate is fully saturated and covered by a centimetre or two of water. Two other *Ctenotus* species were recorded from the site, *C. essingtonii* and *C. storri*.

Specimens from Kapalga were collected in open (wet) woodland on deep sandy soil, near a seasonal seepage zone.

**Etymology.** The new species is named for John McDouall Stuart, first explorer to cross the continent from south to north and survive. He reached the north coast, in the vicinity of the type locality, in July 1862. The name also alludes to Point Stuart, a natural feature of the Northern Territory coast located close to the type locality.

#### *Ctenotus arnhemensis* Storr, 1981 (Figs 5-6)

*Ctenotus arnhemensis* Storr, 1981: 127, Jabiluka, Northern Territory.

**Material examined.** HOLOTYPE - AM R.88613, Jabiluka Mineral Lease, Kakadu National Park, Northern Territory, 12°33'S 132°55'E. PARATYPES - NTM R.7620-23, same data as holotype; NTM R.20253, same data as holotype, except 12°34.6'S 132°54.5'E; NTM R.20254, same data as holotype, except 12°30.8'S 132°54.0'E; NTM R.20255-56, same data as holotype.

**Diagnosis.** *Ctenotus arnhemensis* is distinguished from *C. astictus* sp. nov. by having a complex lateral pattern of stripes, pale spots and blotches and by having generally more ear lobules (mean of 4.8 vs mean of 2.9). Additionally, the relative length of the limbs are usually less in *C. arnhemensis* than in *C. astictus* sp. nov. *Ctenotus arnhemensis* is distinguished from *C. stuarti* sp. nov. by having a generally higher number of subdigital lamellae under the fourth toe (mean of 22.9 vs mean of 21.0) and by having generally fewer nuchal scale pairs (mean of 3.8 vs mean of 4.7). Also, the head of *C. arnhemensis* is usually





Fig. 5. *Ctenotus arnhemensis* (NTM R.20256) from Jabiluka, Northern Territory, photographed in life.

less deep than that of *C. stuarti* sp. nov. (head depth as percentage of head width, mean of 85.7% vs mean of 88.6%). In addition, *C. arnhemensis* has continuous, smooth-edged, white dorsolateral stripes and dark laterodorsal stripes, features which in *C. stuarti* sp. nov. are broken into ragged-edged, semi-continuous series of flecks and streaks.

**Description.** Figures in squared brackets indicate measurements from the original description differing from those of this analysis:

**Head.** Snout length 39-48% (mean = 41.3%) of head length. Prefrontal scales separated by frontal scale. Nuchal scale pairs usually four (89%), occasionally three [3-5, mean = 3.6]. Supraciliary scales usually ten (54%) or nine (46%), fourth to eighth markedly smaller than others. Ciliary scales usually eleven (56%) or ten (33%), occasionally nine [10-14, mean = 11.5]. Usually seven supralabial scales (90%), occasionally eight, fifth under orbit. Infralabial scales usually seven (89%), occasionally eight, two contacting postmental. Ear lobules usually five (67%), occasionally four or six [5-7, mean = 5.5].

**Body.** Snout-vent length to 55.1 mm (mean = 51.1 mm). Axilla to groin length 49-58% (mean = 53.9%) of snout-vent length. Tail length 196-244% (mean = 218%) of snout-vent length [191-237%, mean = 207%]. Paravertebral scales 50-59 (mean = 53.9). Midbody scale rows usually 24 (78%), occasionally 26 [23-27, mean = 24.8].

**Limbs.** Forelimb length 23-28% (mean = 25.8%) of snout-vent length [24-29%, mean = 25.4%]. Hindlimb length 41-49% (mean = 44.2%) of snout-vent length [40-48%, mean = 43%]. Fourth toe length 13-18% (mean = 14.8%) of snout-vent length. Subdigital lamellae under fourth toe 21-26 (mean = 22.9) excluding claw [20-23, mean = 21.4].

**Colour and pattern (in spirit).** The basic body pattern consists of a complex arrangement of smooth-edged, longitudinal stripes, zones of ground colour, pale spots and blotches.

**Body.** Dorsal surface mid-brown, patterned with smooth edged stripes. Dark, blackish-brown vertebral stripe, half as wide as paravertebral scales, extends from anterior nuchal scales to base of tail. Vertebral stripe margined by white



paravertebral stripes which are about one third as wide as vertebral stripe. Paravertebral stripes bordered by zones of mid-brown background colour, about as wide as paravertebral scales, which extend from parietal scales onto tail. Outer margins of background colour zones bordered by prominent, blackish-brown laterodorsal stripes, about three quarters as wide as vertebral stripe, which extend from outer edge of parietal scales onto tail. Outer margins of laterodorsal stripes bordered by distinct, white dorsolateral stripes, about half as wide as vertebral stripe, which extend from outer edge of fourth supraciliary scales onto tail.

Lateral surface of body brown, patterned with pale spots and blotches and pale mid-lateral stripe. Broad blackish-brown upper lateral zone extends from above auricular opening onto tail and patterned with single, regular series of 19-21 large pale blotches. Prominent white mid-lateral stripe, about one third as wide as upper lateral zone, extends from upper posterior margin of auricular opening, above limbs onto tail. Between forelimb and auricular opening, mid-lateral stripe may be broken into series of two or three pale blotches. Brown lower lateral zone, about half as wide as upper lateral zone, extends from below auricular opening to hindlimb. This is patterned anteriorly by four or five pale blotches. Some specimens also with obscure, ragged, pale lower lateral stripe which may only

be visible posteriorly. Where present, this coalesces into immaculate whitish ventral surface.

**Head.** Snout light brown. Dark mottling on frontal, frontoparietal, interparietal and parietal scales. Temporal region brown, patterned with three or four irregular pale blotches. White subocular stripe extends from first loreal scale to mid-upper margin of sixth supralabial scale. Supralabials light brown with pale margins between the scales. Infralabials mottled brown and off-white. White ventral surface changing to cream on chin.

**Limbs.** Mid-brown background colouration on dorsal surface of forelimbs separating three black stripes. Cream on ventral surface. Hindlimbs similar but with four black stripes.

**Tail.** Light brown on dorsal surface. Basal portion has remnants of dark vertebral stripe. Continuations of dark laterodorsal stripes, pale dorsolateral stripes, upper lateral zone and pale mid-lateral stripes extend along length of tail. Cream on ventral surface.

**Distribution.** The known distribution of *C. arnhemensis* is extremely limited, being restricted to within, or the near vicinity of, the Jabiluka and Ranger Project Areas located within Stage One of Kakadu National Park.

**Habitat.** R. Sadlier (pers. comm.) collected the type series on white sandy flats adjacent to the Jabiluka sandstone outlier. Vegetation at these sites consisted of open woodland with a

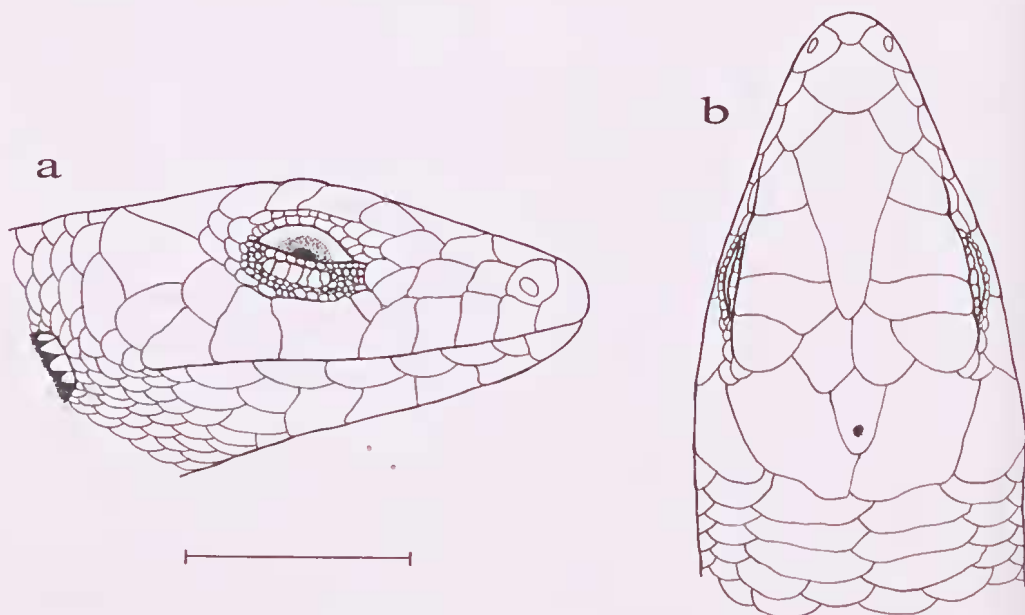


Fig. 6. Holotype of *Ctenotus arnhemensis* (AM R.88613). Head scalation in a) right lateral and b) dorsal view. Scale bar = 5 mm.



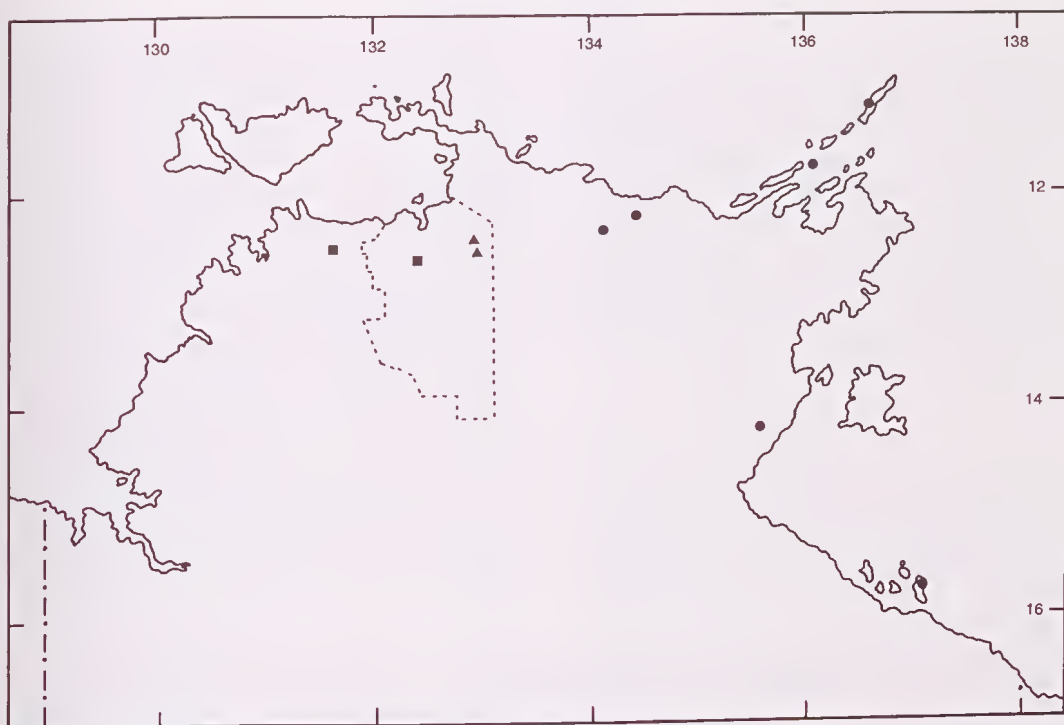


Fig. 7. Map of the Top End region of the Northern Territory showing the distribution of *Ctenopus arnhemensis* (triangles), *C. astictus* sp. nov. (circles) and *C. stuarti* sp. nov. (squares). Outlined area indicates position of Kakadu National Park.

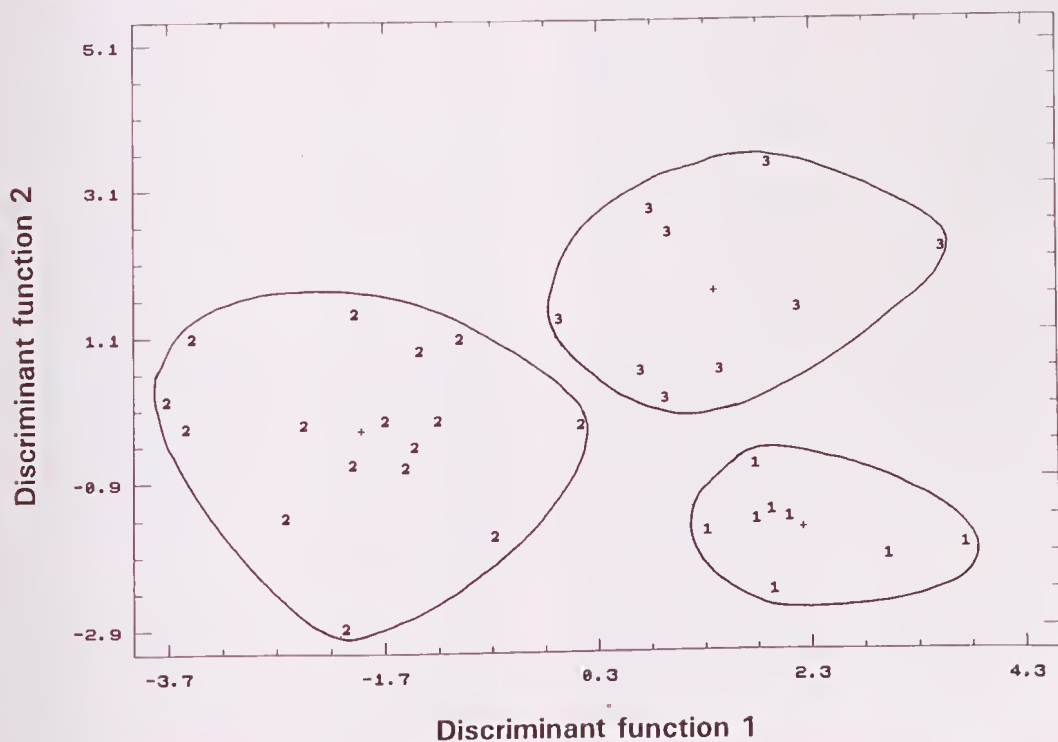


Fig. 8. Plot of discriminant analysis on six variables recorded from 34 specimens of *Ctenopus arnhemensis* (sp.1), *C. astictus* sp. nov. (sp.2) and *C. stuarti* sp. nov. (sp.3).



sparse middle storey of shrubs (eg. *Grevillea* spp.) and a groundstorey of sedge and grass tussocks. Part of the type series was also collected from tall grassland, on humic silt substrate, at the northern end of nearby Island Billabong. Two other *Ctenotus* species were sympatric at these sites, *C. essingtonii* and *C. storri*.

**Variation.** The nine specimens analysed are generally uniform in most morphometric and meristic characters, as well as in body colouration and pattern. Any variation in morphology and meristics is summarised in Table 1.

## DISCUSSION

As an aid to identification of *Ctenotus* in Western Australia, Storr (Storr 1981; Storr *et al.* 1981) distributed the species from that region among ten species-groups. Based on char-

acters in common, these species-groups are not necessarily natural but are useful in clustering similar species together. Wilson and Knowles (1988) tentatively recognised twelve species-groups which include all *Ctenotus* species. *Ctenotus arnhemensis*, *C. astictus* and *C. stuarti* have character states in common that place them in Storr's *C. lesueurii* species-group, the content of which now includes: *C. arcanus* Czechura and Wombey, *C. arnhemensis* Storr, *C. astictus*, *C. borealis* Horner and King, *C. brachyonyx* Storr, *C. capricorni* Storr, *C. coggeri* Sadlier, *C. eurydice* Czechura and Wombey, *C. eutaenius* Storr, *C. fallens* Storr, *C. helenae* Storr, *C. hypatia* Ingram and Czechura, *C. ingrami* Czechura and Wombey, *C. inornatus* (Gray), *C. lateralis* Storr, *C. lesueurii* (Duméril and Bibron), *C. mastigura* Storr, *C. monticola* Storr, *C. nullum* Ingram and Czechura, *C. robustus* Storr, *C. saxatilis*

Table 1. Morphometric and meristic characteristics of *Ctenotus arnhemensis*, *C. astictus* sp. nov. and *C. stuarti* sp. nov.. Measurements are in mm. Tail lengths were measured from original tails only. (SD = standard deviation).

Characteristics	<i>Ctenotus arnhemensis</i> n = 9			<i>Ctenotus astictus</i> sp. nov. n = 16			<i>Ctenotus stuarti</i> sp. nov. n = 9		
	mean	SD	range	mean	SD	range	mean	SD	range
Snout-vent length (SVL)	51.11	3.49	45.9-55.1	47.12	3.22	40.8-51.9	48.85	2.90	42.1-52.0
Tail length	109.33	10.93	94.0-122.1	109.44	8.11	96.0-124.0	111.50	7.78	106.0-117.0
Axilla-groin length	27.63	3.26	32.2-31.6	24.65	2.05	20.0-29.3	25.23	1.90	21.0-27.8
Forelimb length	13.13	1.35	10.8-14.9	13.34	0.69	12.2-14.6	12.74	0.56	11.7-13.3
Hindlimb length	22.50	0.71	21.5-23.3	22.64	1.36	19.9-25.1	21.24	1.22	18.9-23.1
Fourth toe length	7.55	0.36	7.1-8.2	8.12	0.49	7.1-9.1	7.01	0.48	6.4-7.9
Head width	6.14	0.35	5.6-6.5	5.65	0.54	4.6-6.5	5.78	0.41	5.2-6.5
Head depth	5.27	0.50	4.2-5.8	4.92	0.47	3.9-5.9	5.12	0.45	4.4-5.8
Eye-snout (snout) length	4.13	0.07	4.0-4.2	4.07	0.46	3.2-5.1	4.15	0.59	3.4-5.4
Ear-snout (head) length	10.02	0.61	8.7-10.8	9.61	0.76	7.7-10.6	9.87	0.58	8.8-10.5
Forelimb-snout length	16.83	0.53	15.6-17.5	16.71	1.26	13.8-18.6	16.47	1.24	14.7-18.1
No. of supraciliary scales	9.56	0.46	9-10	9.97	0.22	9-11	9.37	0.52	9-10
No. of ciliary scales	10.28	0.62	9-11	10.47	0.72	9-12	10.62	0.69	10-12
No. of supralabial scales	7.05	0.17	7-8	7.03	0.12	7-8	7.06	0.18	7-8
No. of infralabial scales	7.11	0.33	7-8	7.03	0.13	7-8	7.00	0.00	7
No. of nuchal scale pairs	3.78	0.36	3-4	4.03	0.46	3-5	4.67	0.35	4-5
No. of ear lobules	4.78	0.62	4-6	2.94	0.44	2-4	4.11	0.60	3-6
No. of 4th toe lamellae	22.89	1.36	21-26	22.37	1.13	21-25	20.89	1.34	18-23
No. of midbody scale rows	24.44	0.88	24-26	24.25	0.68	24-26	24.89	0.93	24-26
No. of paravertebral scales	53.89	3.02	50-59	52.75	1.95	48-56	54.33	2.91	50-58
ratios									
Tail length to SVL	217.98	16.37	196.3-243.9	228.29	8.28	210.6-238.9	214.83	15.53	203.8-225.8
Axilla-groin length to SVL	53.92	3.15	49.4-58.1	52.30	2.01	49.1-58.2	51.62	1.68	49.3-53.7
Forelimb length to SVL	25.84	1.32	23.5-27.7	28.38	1.73	24.7-32.5	26.12	1.08	24.4-27.8
Hindlimb length to SVL	44.16	2.53	41.5-49.0	48.17	2.42	42.6-51.8	43.50	1.42	41.1-45.1
4th toe length to SVL	14.84	1.50	13.3-17.5	17.26	0.87	15.5-18.6	14.37	0.96	12.8-16.1
Head depth to head width	85.73	5.69	74.6-91.5	87.23	6.09	75.0-96.3	88.60	4.90	80.6-96.6
Orbit-snout to Ear-snout	41.33	2.74	38.9-47.8	42.38	2.61	39.5-49.4	42.06	5.04	38.6-54.2
Ear-snout to SVL	19.63	0.94	18.5-21.0	20.37	0.91	18.6-21.9	20.23	0.44	19.5-20.9
Forelimb-snout to SVL	33.05	2.34	29.9-37.1	35.48	1.54	33.4-37.5	33.75	1.63	31.2-35.7



Storr, *C. severus* Storr, *C. spaldingii* (Macleay), *C. stuarti*, *C. taeniolatus* (White, ex Shaw), *C. terrareginae* Ingram and Czechura, and *C. vertebralis* Rankin and Gillam.

*Ctenotus arnhemensis*, *C. astictus* and *C. stuarti* have no single morphometric or meristic character to distinguish them. Their body patterns are distinctive, but require support to warrant species separation. Table 1 shows that many variables recorded for each of these species have different means, but have considerable overlap. Six of these, those used to distinguish between the three taxa, were subjected to a Discriminant Analysis using the program Statgraphics (version 5). Figure 8 illustrates that this analysis separated individual specimens into three discrete groups, corresponding to *C. arnhemensis* (sp.1), *C. astictus* (sp.2) and *C. stuarti* (sp.3). With high canonical correlation coefficients (above 0.78) and low significance levels (less than 0.0001) indicating that the discriminant functions are significant, the discrimination analysis results show that several characters, used in combination, can distinguish between these three species.

The three species appear to be allopatrically distributed (Fig. 7). Kakadu National Park (19,757 km<sup>2</sup>) bisects the Top End of the Northern Territory and has been the subject of numerous, intensive faunal surveys, none of which have recorded the presence of *C. astictus* or have found *C. arnhemensis* other than in, or adjacent to, the Jabiluka and Ranger Project Areas (200 km<sup>2</sup>). *Ctenotus stuarti* has been recorded from Kakadu National Park, at Kapalga in Stage Two but is apparently absent from Stages One and Three. Interestingly, Kapalga has been the subject of faunal studies for many years, but *C. stuarti* is only known from two individuals collected at a single study site. Thus, the three species appear to have restricted distributions, a finding that is supported by the number of other *Ctenotus* species in the Top End only known from small geographic areas. Examples of lowland forms of these are: *C. borealis* Horner and King; *C. gagudju* Sadlier, Wombey and Braithwaite; *C. hilli* Storr; *C. kurnbudj* Sadlier, Wombey and Braithwaite; and, *C. storri* Rankin (see distributions in Horner 1992).

Habitat preferences of *C. arnhemensis*, *C. astictus* and *C. stuarti* are similar, all occurring on white, sandy flats with an open woodland or open shrubland upperstorey, and a groundstorey of perennial grass and/or sedge tussocks. Each

species also shares sympatry with *C. essingtonii* and, in the case of *C. arnhemensis* and *C. stuarti*, *C. storri*. Sadlier, Wombey and Braithwaite (1986) discussed the habitat preferences of *Ctenotus* species in the Alligator Rivers region of the Top End. Of eight species, they recorded three examples of two species occurring in ecological sympatry (syntopy) and one example of three species being syntopic (*C. arnhemensis*, *C. essingtonii* and *C. storri*). They explained the region's diversity of *Ctenotus* as being due to the diverse habitats found in the region, and diversity within habitats by the size differences between species and in the way that similar-sized species partition resources, such as microhabitat, food and activity period.

The addition of two new species of *Ctenotus* to the fauna of the Top End means that, in the Northern Territory, tropical forms now almost rival in number those of the arid centre. With the strong possibility of more species to be described from the region, the monsoonal north of Australia may, in future, rival the arid centre in diversity of *Ctenotus*.

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